IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Assistive Technology For Visually Impaired

[1]Gaurav Singh , [2]Hrishikesh Waghmare, [3]Shubhangi Jadhav, [4]Shreyas Karale, [5]Dr. Rohan R. Kubde

[1 2 3 4]UG Student, Department of Electronics and Telecommunication Sinhgad Institute of Technology and Science, Pune

[5]Assistant Professor, Department of Electronics and Telecommunication Sinhgad Institute of Technology and Science, Pune

Abstract: Blindness limits a person's ability to perceive their surroundings, making independent navigation, object recognition, obstacle avoidance, and reading significantly more challenging. This work introduces a novel visual assistance system specifically designed for individuals with complete blindness. The Raspberry Pi 4 Model was selected for the prototype due to its affordability, compact size, and ease of integration. The system incorporates a camera and sensors for obstacle detection, using both distance measurements from ultrasonic sensors and the camera. Advanced image processing algorithms handle object recognition, while a text-to-speech module provides auditory feedback from the integrated reading assistant, which converts images to text.

Index Terms: Assistive Technology, Object Detection, Ultrasonic Sensor, Camera Module, Visually Impaired, Text-to-Speech (TTS), Real-Time Feedback

I. Introduction

Globally, over 285 million people suffer from visual impairments, with approximately 39 million of them being completely blind, according to the World Health Organization (WHO). For individuals with severe visual impairments, daily tasks such as navigating through unfamiliar environments, identifying objects, and reading printed text can pose significant challenges. These limitations hinder independence and often lead to increased reliance on external support, such as white canes, guide dogs, or human assistance.

In recent years, advances in assistive technology have introduced new possibilities for enhancing the autonomy of visually impaired individuals. Existing solutions, including ultrasonic canes, smart glasses, and obstacle detection systems, have made strides in improving navigation and awareness of the surroundings. However, these solutions often suffer from limitations in real-time object recognition accuracy, range, and ease of use, especially when it comes to seamless integration with text-to-speech (TTS) functionalities for reading purposes.

This paper proposes an advanced assistive technology solution that integrates an ultrasonic sensor and a camera module for real-time object detection, combined with a text-to-speech (TTS) converter to aid in reading. The system is designed to provide visually impaired individuals with real-time auditory feedback about nearby obstacles and objects while offering a reading assistant through voice-based text conversion. By leveraging computer vision techniques and ultrasonic sensing, the proposed system offers a low-cost, portable, and efficient solution to the existing gaps in current assistive technologies.

II. RELATED WORK

Research on assistive technologies for visually impaired individuals has seen significant advancements, particularly in object detection and text-to-speech systems. These technologies have aimed to enhance the autonomy and quality of life for people with visual impairments by facilitating safer navigation and improved access to textual information.

Object Detection Systems:-
One of the key developments in assistive technologies has been the use of **deep learning-based object detection** systems. Models like **YOLO (You Only Look Once)** have gained attention for their speed and accuracy in real-time object recognition, making them particularly suitable for wearable devices and navigation aids for visually impaired users. This systems can detect multiple objects in the user's surroundings and provide real-time auditory feedback, which is crucial for safe navigation. For example, researchers have integrated these models into wearable devices like **smart glasses**, which use a combination of cameras and object detection algorithms to identify obstacles and alert users through audio signals.

However, a common shortcoming of these object detection systems is their performance in complex or unstructured environments, where lighting conditions or object occlusion can significantly degrade accuracy. Additionally, while these systems are capable of identifying objects, they often lack the ability to convey detailed contextual information that would further enhance a user's understanding of the environment.

III. AIM

"To develop an intelligent assistive system that empowers visually impaired individuals by providing real-time object detection, text-to-speech conversion, enhancing their independence, accessibility, and ability to navigate daily tasks with greater ease and confidence."

IV. PROBLEM STATEMENT

Visually impaired individuals face challenges in recognizing objects, reading text. Existing assistive technologies are often limited, expensive, or lack real-time functionality, making it difficult for users to achieve full independence. There is a need for an affordable, user-friendly solution that integrates real-time object detection, text-to-speech conversion ,to enhance accessibility and independence for visually impaired people.

V. OBJECTIVES

The core objective of the Assistive Technology For Visually Impaired project is to develop a robust real-time object detection system that accurately identifies object in user's surrounding facilitating immediate spatial awareness

1. **Develop Real-time Object Detection**:
   Develop an object detection system that recognizes common items in real-time and delivers audio feedback to users with visual impairments.

2. **Integrate Text-to-Speech Conversion**:
   Create a system that can recognize printed text and convert it into audible speech to assist users in reading documents, signs, and labels.

3. **Enhance Accuracy and Speed**:
   Aim to achieve high accuracy in recognizing objects and text while ensuring real-time processing speed..

VI. LITERATURE SURVEY

Wearable haptic device as a mobility aid for blind people: Electronic Cane, 2023.

Develop and evaluate haptic systems that can be integrated into canes for visually impaired individuals, enhancing their ability to detect obstacles and provide timely alerts to users.

Haptic feedback for blind individuals in indoor environments using vibration patterns, 2022.

Gather feedback from visually impaired individuals on an instant feedback system designed to convey information through specific vibration patterns..

Enhancing the usability of tactile maps for the visually impaired, 2020.

Develop and assess the effectiveness of tactile maps for individuals with visual impairments.

Touch-based system and development of a braille writing system, 2019.

Develop and evaluate the effectiveness of tactile maps for people with visual impairments.

An outdoor navigation system for blind pedestrians using GPS and tactile feedback, 2018.

Evaluate the effectiveness of GPS technology and tactile sensory devices in enhancing the mobility of individuals with visual impairments.

VII. PROPOSED METHODOLOGY

1. Object Detection Pipeline

1.1 Data collection:

Sensors**:** The system uses a combination of an ultrasonic sensor and a camera for real-time object detection The ultrasonic sensor is used to detect the distance of objects in the user's path to avoid obstacles The camera captures images and video to identify and classify objects in the environment.

1.2 Data Processing:

Preprocessing**:**

The data from the camera is first pre-processed to adjust lighting, sharpness, and contrast for better detection. The ultrasonic sensor data is used to determine object proximity and enhance the object detection accuracy.

1.3 Object Detection Algorithm:

YOLO (You Only Look Once) or **SSD (Single Shot Multibox Detector)** models can be used to detect objects within the camera's frame. These models are known for their speed and accuracy in real-time object detection tasks. The detected objects are classified into different categories (e.g., furniture, vehicles, people).

1.4 Data Analysis:

Once objects are detected and classified, the system prioritizes relevant objects (e.g., obstacles in the user's path) and assigns spatial orientation data

2. Voice Feedback Mechanism

2.1 Object-to-Voice Conversion:

Object Description:

For each detected object, the system generates a description, such as "Table ahead" or "Person approaching."

2.2 Voice Feedback:

The description is converted into speech using **text-to-speech (TTS)** software, such as Google's Text-to-Speech API or Microsoft's Speech SDK. The voice feedback is provided in real-time through an audio device (e.g., a Bluetooth earpiece or speaker), guiding the user to navigate safely.

2.3 Real-time Navigation:

The combination of object detection and real-time voice feedback allows the user to know their surroundings and take appropriate action.

3. Text-to-Speech (TTS) Conversion

3.1 Scanning Printed Material:

OCR: The system uses OCR technology to recognize and scan printed or handwritten text. Libraries such as Tesseract OCR or cloud-based solutions like **Google Cloud Vision** can be employed for text extraction. The user can trigger the camera to scan a document, a sign, or a label to capture the text.

3.2 Converting Text to Speech:

Once the system recognizes the text, it processes it using the Text-to-Speech engine, converting it into natural-sounding speech.

The processed text is read out to the user, enabling them to "read" printed materials, such as books, labels, or currency.

Customization and Languages:

The TTS system can be customized to support multiple languages and dialects, allowing the suser to select their preferred language.

VIII. System Design

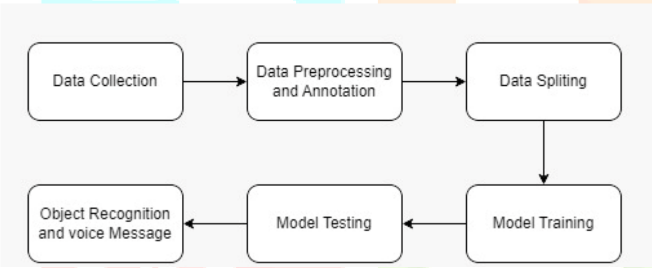
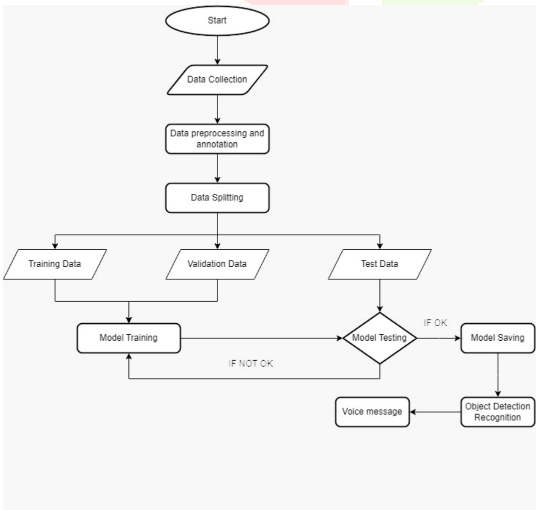


Figure: Block Diagram

IX. Flow Chart



Functional Requirement

1. Object Detection

1.1: The system shall detect objects in real-time using a camera and ultrasonic sensor.

1.2: The system shall classify objects (e.g., furniture, vehicles, people) within the camera's field of view.

1.3: The system shall provide real-time audio feedback about detected objects, including their proximity and relative location (e.g., "chair ahead, 2 feet away").

14: The system shall detect obstacles and alert the user to avoid them with directional instructions (e.g., "move left").

2. Text-to-Speech (TTS) Conversion

2.1: The system will scan printed or handwritten text using Optical Character Recognition (OCR)

2.2: The system will convert recognized text into speech using a Text-to-Speech engine.

2.3: The system shall support multiple languages and allow users to select their preferred language for speech output.

2.4: The system shall read aloud text from various sources, such as signs, books, or product labels, when requested by the user.

3. Connectivity and Data Processing

3.1: The system shall process data locally on a portable device (e.g., Raspberry Pi) to ensure real-time responses.

3.2: The system shall support output to wired headphones.

4. Power Management

4.1: The system shall operate on a portable power source (e.g., rechargeable battery) and provide a low-power mode when not actively in use.

4.2: The system shall alert the user when the battery is low and requires charging.

5. Performance

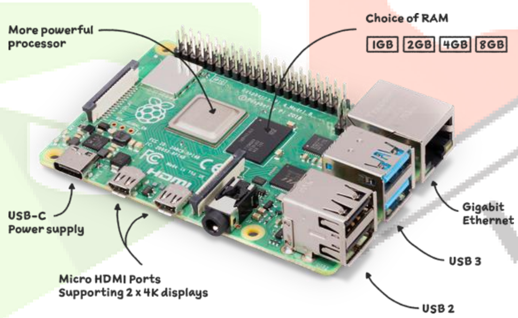
5.1: The system shall detect and classify objects in real-time, with a response time of less than 2 seconds.

5.2: The system shall have a recognition accuracy of at least 90% for objects, text, and currency under varying lighting conditions.

5.3: The system shall function effectively both indoors and outdoors, adapting to different environmental conditions.

X. Components Description

Raspberry Pi



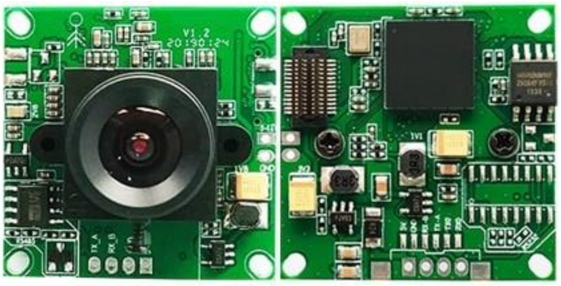
- **The Raspberry Pi 4 is a single-board computer** with a powerful Broadcom BCM2711 quad-core Cortex-A72 processor..
- **It acts as a bridge between software and hardware**, enabling communication with sensors, cameras, and other peripherals through its 40 GPIO pins.
- **It works as a full computer**, capable of running high-level programming languages like Python, C++, and Java allows users to store and run various programs and software applications.
- **The Raspberry Pi 4 can be connected to the internet** via Wi-Fi or Ethernet, enabling it to work with cloud services, communicate with other devices, and process data remotely.

Ultrasonic Sensor(SR-100)

- Ultrasonic Sensor SR-100 is an electronic device that uses sound waves to detect objects and measure distances.

- SR-100 emits ultrasonic sound waves and detects the reflection from objects to determine distance.
- It can measure the distance to an object by calculating the time taken for the sound waves to bounce back.
- The SR-100 sensor is capable of detecting objects within a specific range, typically between 2 cm and 4 meters.
- This sensor provides reliable measurements regardless of surface color, lighting conditions, or transparency, unlike optical sensors.SR-100 is commonly used in obstacle detection, robotics, and distance measurement applications.

Camera Module



- A compact device used to capture still images and video, often used in embedded systems.
- Typically connects to microcontrollers or single-board computers (like Raspberry Pi) via CSI (Camera Serial Interface) or USB.
- Available in various resolutions, typically ranging from 2 MP to 12 MP or higher.
- Commonly used for surveillance, object detection, computer vision, and robotics.
- Small and lightweight, making it ideal for portable embedded projects.
- Some models include IR capabilities for night vision, or low-light photography.
- Works with libraries like OpenCV for image processing and machine learning applications.

XI. RESULTS

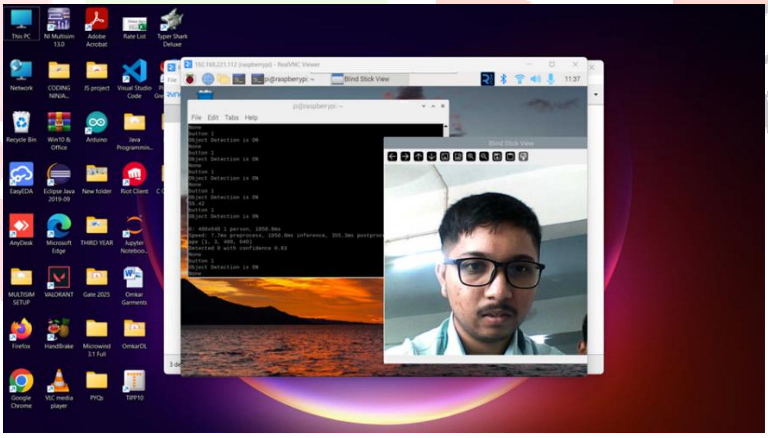


Figure: Object Detection

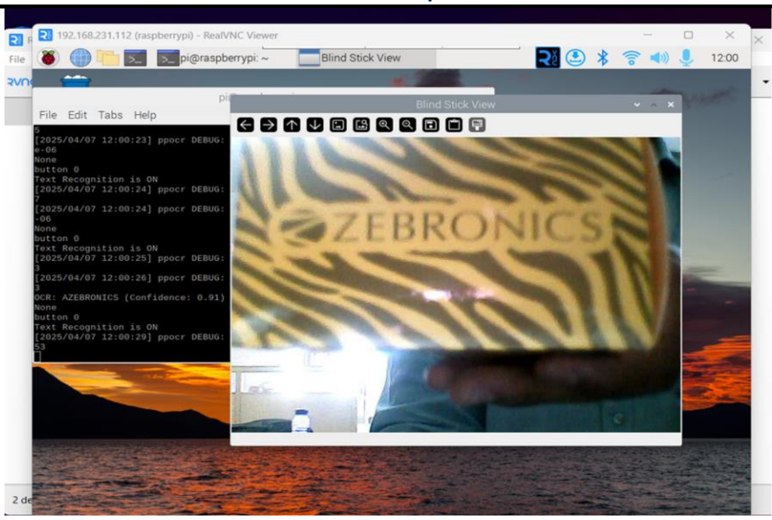


Figure: Text To Speech

XII. Conclusion

The Assistive Technology for Visually Impaired project effectively enhances the independence and accessibility of visually impaired individuals by integrating real-time object detection and text-to-speech conversion. The object detection feature allows users to identify obstacles and important objects in their surroundings, promoting safer navigation and building confidence in daily activities. Meanwhile, the text-to-speech capability enables users to access printed materials and receive spoken feedback, significantly improving their interaction with written information.

Overall, this project emphasizes inclusivity and empowerment, aiming to improve the quality of life for visually impaired individuals. Future enhancements could further refine these capabilities, making the technology even more effective in creating a more accessible world.

XIII. References

[1] Blindness and vision impairment, World Health Organization, Geneva, Switzerland, Oct. 2019. [Online]. Available: https://www.who.int/newsroom/fact-sheets/detail/blindness-andvisual-impairment

[2] J. Bai, S. Lian, Z. Liu, K. Wang, and D. Liu, "Virtual-blind-road following-based wearable navigation device for blind people," *IEEE Trans. Consum. Electron.*, vol. 64, no. 1, pp. 136–143, Feb. 2018.

[3] B. Li, Y. Zhang, J. Xiao, X. Li, and J. Zhang, "Vision-based mobile indoor assistive navigation aid for blind people," *IEEE Trans. Mobile Comput.*, vol. 18, no. 3, pp. 702–714, Mar. 2019.

[4] J. Xiao, S. L. Joseph, X. Zhang, B. Li, X. Li, and J. Zhang, "An assistive navigation framework for the visually impaired," *IEEE Trans. Human-Mach. Syst.*, vol. 45, no. 5, pp. 635–640, Oct. 2015.

[5] A. Karmel, A. Sharma, M. Pandya, and D. Garg, "IoT based assistive device for deaf, dumb and blind people," *Procedia Comput. Sci.*, vol. 165, pp. 259–265, 2019.

[6] C. Ye and X. Qian, "3-D object recognition of a robotic navigation aid for the visually impaired," *IEEE Trans. Neural Syst. Rehabil. Eng.*, vol. 26, no. 2, pp. 441–450, Feb. 2018.

[7] Y. Liu, N. R. B. Stiles, and M. Meister, "Augmented reality powers a cognitive assistant for the blind," *eLife*, vol. 7, Nov. 2018, Art. no. e37841.

[8] A. Adebiyi, L. P. Barry, M. D. Thomas, and R. G. Simpson, "Assessment of feedback modalities for wearable visual aids in blind mobility," *PLoS One*, vol. 12, no. 2, Art. no. e0170531, Feb. 2017.

[9] J. Bai, S. Lian, Z. Liu, K. Wang, and D. Liu, "Smart guiding glasses for visually impaired people in indoor environment," *IEEE Trans. Consum. Electron.*, vol. 63, no. 3, pp. 258–266, Aug. 2017.

[10] D. Dakopoulos and N. G. Bourbakis, "Wearable obstacle avoidance electronic travel aids for blind: A survey," *IEEE Trans. Syst. Man, Cybern. C*, vol. 40, no. 1, pp. 25–35, Jan. 2010.

[11] E. E. Pissaloux, R. Velazquez, and F. Maingreaud, "A new framework for cognitive mobility of visually impaired users using a tactile device," *IEEE Trans. Human-Mach. Syst.*, vol. 47, no. 6, pp. 1040–1051, Dec. 2017.

[12] K. Patil, Q. Jawadwala, and F. C. Shu, "Design and construction of electronic aid for visually impaired people," *IEEE Trans. Human-Mach. Syst.*, vol. 48, no. 2, pp. 172–182, Apr. 2018.